Chemical Composition and Fermentation Characteristics of Silages of Potato, Sweet Potato and Turnip with Rice Straw and Studies the Effect of Rations Containing Its Silages on Performance and Economical Efficiency of Growing Lambs

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Abstract: The objectives of this study were evaluation the silages containing non-commercial potato tubers, sweet potato roots, and turnip roots mixing with rice straw and its effect on lambs' performance. Silages were making automatically in bags. Chemical composition and fermentation characteristics were measured for these silages. Twenty-four lambs averaged weight 19.4 kg were divided into four groups to evaluate 4 rations (6 in each): Ration A was 100% of CP requirements according to NRC from CFM + Rice straw *ad lib*. Rations B, C and D were 60% of CP requirements according to NRC from CFM + silages *ad lib*. of potato, sweet potato and turnip, respectively for 28 weeks. The lambs were weighed biweekly. Digestibility trials and animal performance were conducted to evaluate rations A, B, C and D. Results showed that DM of potato silage, sweet potato silage and turnip silage was 38.15, 38.34 and 32.25%, respectively. OM was 85.46, 83.97 and 88.47%, respectively. CP was 12.06, 13.56 and 11.16%, respectively. Fermentation characteristics of silages of potato, sweet potato and turnip explained that pH was 4.09, 3.80 and 4.07, respectively. Ammonia-N was 0.28, 0.29 and 0.26 g/100g DM, respectively. Ammonia-N% of total N was 14.68, 13.46 and 14.59, respectively. Acetic acid was 2.77, 2.66 and 3.20g/100g DM, respectively. Butyric acid was 0.44, 0.73 and 0.83g/100g DM, respectively. Lactic acid was 7.01, 7.43 and 8.64g/100g DM, respectively. Digestion coefficients of rations A, B, C and D was DM digestibility was 68.03, 54.60, 63.28 and 57.75%, respectively, OM digestibility was 70.39, 59.09, 64.58 and 61.1%, respectively, CP digestibility was 70.41, 64.20, 71.69 and 65.50%, respectively, CF digestibility was 55.64, 53.07, 52.65 and 49.11, respectively, EE digestibility was 90.74, 86.11, 88.61 and 89.02%, respectively and NFE digestibility was 73.30, 58.56, 65.56 and 62.12%, respectively. TDN was 67.96, 55.52, 60.34 and 59.5%, respectively and DCP was 10.46, 9.52, 11.08 and 9.62%, respectively. Ruminal pH after feeding was significantly decreased than before feeding and the differences among all rations were not significant at 4h post feeding. Ruminal pH values in all rations ranged from 5.58 to 6.91. Ruminal NH_3-N and total VFA were significantly increased after feeding than before feeding. NH_3-N in the rumen of ration C was significantly lower than other rations while the differences among other rations were not significant. The differences of ruminal VFA's among all rations were not significant except rations A was significantly lower than other rations. Microbial protein of rations A, B, C and D was 0.26, 0.39, 0.37 and 0.39 gm/100 ml rumen liquor, respectively. The average DM intake of rations A, B, C and D was 1.285, 0.942, 0.955 and 0.901 kg/lamb/d, respectively, daily body gain was 107.99, 109.69, 112.24 and 120.75 g/lamb/d, respectively and feed conversion was 11.90, 8.56, 8.53 and 7.45 Kg DM/Kg gain, respectively. The feed cost of rations A, B, C and D was 5.806, 4.402, 4.892 and 4.283 LE/lamb/d, respectively and economical efficiency was 1.12, 1.49, 1.38 and 1.69, respectively.

Keywords: Potato, sweet potato, turnip, silage, lambs, Digestion coefficients, Ruminal parameters, economical efficiency

INTRODUCTION

The utilization of untraditional feeds such as non-commercial roots and tubers and cereal crop residues may provide farmers with a variety of feeding cheap for their animals. In Egypt, potato cultivated area was 376631 feddan produced 4113441t from tubers, sweet potato cultivated area was 32086 fedden produced 454493t from roots and turnip cultivated area is 4572 fedden produced 45434t from roots (MALR, 2018). The main yield is using for human consumption and the by-products such as green wastes and non-commercial tubers and roots such as small, very large, broken and unmarketable could be used for animal feeding. These tubers and roots could be mixing with crop residues for making good silage. Sadri *et al.* (2018) found that DM was 32.2% and CP, pH, ammonia-N, butyric acid and lactic acid of potato with wheat straw silage were 4.7%, 4.3, 59.8 g/kg total N, 0.047 g/kg DM and 6.53 g/kg DM, respectively. Mutavhatsindi *et al.* (2018) found that DM was 35.2% and CP, pH, ammonia-N, butyric acid and lactic acid of potato hash with wheat bran silage were 14.1%, 3.51, 0.43% total N, 0.13 g/kg DM and 66.4 g/kg DM, respectively. Rui-rui *et al.* (2018) found that pH, ammonia-N and lactic acid of potato pulp with corn straw silage were 3.79, 1.85% total N and 0.8% DM, respectively. Babaeinasab *et al*. (2015) found that DM was 32.2% and CP, pH, ammonia-N, butyric acid and lactic acid of potato with wheat straw silage were 14.3%, 4.1, 61.3 g /kg total N, 0.014 g/kg DM and 6.94 g/kg DM, respectively. Sugimoto *et al.* (2010) found that DM and CP of potato pulp with wheat bran silage were 24.6% and 13.6% and Hart and Horn (1987) mentioned that DM was 33.2% and CP, pH, ammonia-N, butyric acid and lactic acid of silage contained 27.7% wheat straw and 72.3% turnip were 10.5%, 4.6, 2.2 mg/g DM, 2.3 mg/g DM and 46.9 Mg/g DM, respectively. Yongzai *et al.* (2015) mentioned that NH_3-N and acetic acid were reduced in silages of potato with additives molasses. HaiYan *et al.* (1998) noticed that no significant differences in ammonia-N concentration among different silages of turnip containing 6, 12 and 18% wheat straw. Sadri *et al*.

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(2018) found that digestion coefficient of DM, OM,CP and EE of ration containing 20% potato-wheat straw silage + CFM + alfalfa by lambs was 67.2%, 70%, 66.3% and 74.3%, respectively. Hart and Horn *et al.* (1987) found that OM digestibility was 63% and ruminal pH ranged from 6.65 to 6.88, ammonia N ranged from 6.5 to 12.9 mg/dl and VFA ranged from 66.6 to 86.9 mmol/L at 3h post feeding of rumen liquor of lambs fed silage containing 72.3% turnip and 27.7% wheat straw. Sadri *et al.* (2018) noticed that average daily gain (ADG) of growing lambs was increased with increasing potato-wheat straw silage in the rations up to 300 g/kg DM. Nkosi and Meeske (2010) found that ADG was 192 g/d of lambs fed ration containing 20% potato hash silage with CFM. Nkosi and Ratsaka (2010) found that feed conversion was 10.2 of lambs fed ration containing 22.5% silage of potato hash and hay + CFM. Potato pulp can be low cost feed sources for livestock (Sugimoto *et al*., 2009). This work aimed to study the effect of rations containing silages of non-commercial potato tubers, sweet potato roots, and turnip roots with rice straw on lamb's performance and its economical efficiency.

MATERIALS AND METHODS

This study was carried out at Animal Production Research Institute, Agricultural Research Center, Egypt. Silages were making automatically in bags at cooperative society for Livestock at Hanna merhem, Abohammad (Sharkia governorate). Potato tubers, sweet potato roots and turnip roots were cutting by using a special cutting machine then mixed with chopped rice straw (75% tubers or roots and 25% rice straw) then mixed with 2% molasses. The three mixtures were press automatically by a piston to press the mixtures in bags capacity 35 kg to get anaerobic conditions. Silages were used for feeding growing lambs at El-Gemiza Research Station (Elgharbia Governorate). The bags were opened after 45 days for animal feeding.

Twenty-four local growing lambs averaged 19.4 kg body weight were divided into four groups (6 in each) and were randomly assigned to evaluate the following rations:

Ration A (control): 100% of CP requirements according to NRC (1985) from concentrate feed mixture (CFM) + Rice straw *ad lib.*

Ration B: 60% of CP requirements according to NRC (1985) from CFM + silage of potato.

Ration C: 60% of CP requirements according to NRC (1985) from CFM + silage of sweet potato.

Ration D: 60% of CP requirements according to NRC (1985) from CFM + silage of turnip.

The CFM was daily offered to the animals in two equal portions at 8 am and 4 pm. The silages were weighed and offered *ad lib*. Residual was collected and weighed daily. Drinking water was available all time. The growth experiment lasted 28 weeks (196 days). The experimental lambs were weighed biweekly (every two weeks) in the morning before feeding.

Four digestibility trials were conducted to evaluate the experimental rations (A, B, C and D) using 12 lambs from the experimental treatments (3 lambs in each) averaged weight 36.5 kg. The lambs were individually housed in metabolic cages then individually fed. Preliminary period was 15 days and collection period were 5 days, followed 3 days of rumen fermentation studies.

Composite samples of CFM, rice straw, silages of potato, sweet potato and turnip were dried in oven at 60ºc for 24h. Samples of daily feces were collected and dried in oven at 60ºc for 24 h. Composite samples of feeds and feces were milling to pass through 1 mm screen and stored for chemical analysis. Chemical composition of representative samples of CFM, RS, silages, feces were determined according to AOAC (1995) procedures.

Samples of silages were prepared for analysis silage characteristics by extracting homogenized 50 gm (wet material) with 500 ml distilled water for 10 minutes in a warming blender (Waldo and Schultz, 1956), the homogenate was filtered through four-layer cheese cloth. The filtrate was used to determine pH directly using a digital pH meter. Ammonia nitrogen (NH_3-N) was determined according to AOAC (2016). Acetic, butyric and lactic acids were determined by the distillation method as reported by Research Institute for cattle feeding at Hoorn, Holland (1961) as described by Nowar (1969).

Rumen fluid samples were taken from lambs using a stomach tube at 0 times (before feeding), 2h and 4h post feeding. These samples were filtered through three layers of surgical gauze without squeezing. Ruminal pH was immediately estimated by digital pH meter. Rumen ammonia-N was determined according to Conway (1957). Total volatile fatty acids (TVFAs) were measured by the steam distillation method as described by Warner (1964). Microbial protein was determined by the sodium tungstate method according to Shultz and Shultz (1970).

Growth performance indices were calculated as follows:

Average daily gain (ADG) = $\frac{\text{Final body weight} - \text{Initial body weight}}{\text{Number of days}}$

Growth rate (GR, %) = $\frac{\text{Final body weight} - \text{Initial body weight}}{\text{Initial body weight}} \times 100$

Economical efficiency = $\frac{\text{Price of weight gain}}{\text{cost of consumed feeds}}$

Feed conversion = $\frac{\text{Total DM intake (kg)}}{\text{Total live body gain (kg)}}$ Or = $\frac{\text{average daily DM intake (kg)}}{\text{average daily body gain (kg)}}$

All data were subjected to analysis was performed using the General linear Models (GLM) procedure of the SPSS 24. Mean differences were compared using Duncan ' multiple range test (Duncan, 1955). Data were analyzed using the following mathematical model:

Yij = μ + Ti + eij

Yij = Individual observation, μ = over all mean, Ti= effect of the i^{th} treatments and eij = Random residual error.

RESULTS AND DISCUSSION

Chemical analysis of experimental silages of Potato, Sweet potato and turnip with RS are presented in Table (1). Chemical composition of silages indicated that DM content of potato silage, sweet potato silage and turnip silage was 38.15, 38.34 and 32.25%, respectively. DM percent in this study was nearly similar with Mutavhatsindi *et al.* (2018) (35.2%), Sadri *et al.* (2018) (32.2%), Babaeinasab *et al*. (2015) (32.2 - 36.0%), Hough *et al.* (1994) (38.2%) and Hart and Horn (1987) (32.2%). OM of potato silage, sweet potato silage and turnip silage was 85.46, 83.97 and 88.47%, respectively. CP of potato silage, sweet potato silage and turnip silage was 12.06, 13.56 and 11.16%, respectively. However, CP percent in silage depends on protein in silage components. Hadgu *et al.* (2015) found that CP in sweet potato silage ranged from 10.9 to 16.2%. Hough *et al.* (1994) found that CP ranged from 10.25 to 11.15% of potato-hay silage, Pen *et al*. (2006) found that CP was 14.4% in silage of potato by-products + corn cob + beet pulp + culled bean, Sugimoto *et al.* (2010) found that CP was 13.6% in silage of Potato pulp + wheat bran and Sugimoto *et al.* (2007) found that CP was 12.5% in silage of potato pulp + 0.5% urea.

Table (1): Chemical composition (% on DM basis) of concentrate feed mixture (CFM*), rice straw (RS) and silages of potato, sweet potato and turnip with rice straw

Chemical composition	CFM*	RS	Silages		
			Potato silage	Sweet potato silage	Turnip silage
DM	92.21	89.36	38.15	38.34	32.25
OM	91.65	86.25	85.46	83.97	88.47
CP	16.81	3.25	12.06	13.56	11.16
EE	3.80	1.86	1.12	1.64	3.72
CF	12.38	38.23	30.82	28.90	27.84
NFE	58.66	42.91	41.46	39.87	45.75
Ash	8.35	13.75	14.54	16.03	11.53

*CFM was formulated from 24% Sunflower meal, 15% wheat bran, 55% yellow corn, 3% molasses, 2% lime stone and 1% common salt.

The silage fermentation characteristics of silages of potato, sweet potato and turnip with rice straw as shown in Table 2 explained that pH of sweet potato silage (3.80) was significantly ($P<0.05$) lower than potato and turnip silages (4.09 and 4.07). Similar values were obtained by Rui-rui *et al.* (2018) who found that pH value was 3.79 in potato pulp with corn straw silage. Hadgu *et al.* (2015) who found that pH ranged from 3.64 to 3.89 with sweet potato silage. Hart and Horn (1987) noticed pH value of silage containing 72.3% turnip and 27.7% wheat straw was 4.6. However, good quality silage is containing pH under 4.8 (Alberta Agriculture Food and Rural Development 2004). Ammonia-N as g/100g DM of turnip silage was significantly ($P<0.05$) lower than potato and sweet potato silages while ammonia-N% of total N of sweet potato silage was significantly ($P<0.05$) lower than potato and turnip silages. However, ammonia-N% of all silages was less than 15% of total N. These results agreed with Nicholson and Macleo (1966) who found that ammonia N in various silages ranged from 11.9 to 16.5% of total N and Rigueira *et al.* (2013) who found that ammonia-N ranged from 10 to 20.7 from total N Ammonia-N% of total N in this study was higher than that obtained by Rui-rui *et al.* (2018) with potato pulp and corn straw silage and Babaeinasab *et al.* (2015) with potato-wheat straw. However, Kung *et al.* (2018) mentioned that NH_3-N usually less than 15% of total N of silage and Mahanna (1994) mentioned that silages containing 10-15% ammonia-N of total N are considered of good quality silage. Generally, ammonia-N from silage with available energy in the rumen is using by rumen microorganisms for synthesis microbial protein. Acetic acid of turnip silage (3.2 g/100g DM) was significantly ($P<0.05$) higher than potato and sweet potato silages (2.77 and 2.66 g/100g DM).similar values was obtained by Giang *et al.* (2004) who found that acetic acid ranged from 23.8 to 26.9 g/kg DM in sweet potato silage and Hart and Horn (1987) who found that acetic acid ranged from14 to 43.0 Mg/g DM in turnip-wheat straw silage and were higher than that obtained by Rui-rui *et al.* (2018) in potato pulp-corn straw silage and Nkosi and Meeske (2010) in potato hash-hay silage. Butyric acid of potato silage (0.44 g/100g DM) was significantly ($P<0.05$) lower than sweet potato and turnip silages (0.73 and 0.83 g/100g DM). However, butyric acid in all silages was less than 1%. Similar results were showed by Kung *et al.* (2018) and Nicholson and Macleo (1966). Giang *et al.* (2004) found that butyric acid ranged from 0.33 to 0.47 g/kg DM of sweet potato silage. Lactic acid in turnip silage (8.64g/100g DM) was significantly ($P<0.05$) higher than potato and sweet potato silages (7.01 and 7.43 g/100g DM). Okine *et al.* (2005) found that lactic acid ranged from 6.32 to 6.73% DM in Potato pulp silage. Giang *et al.* (2004) found that lactic acid ranged from 11.97 to 12.45% DM in sweet potato silage. Hart and Horn (1987) found that lactic acid was 4.69% DM in turnip-wheat straw silage. However, the values of lactic acid of all silages lie within the normal data of good quality silage as reported by Zobell *et al.* (2005) who stated that the lactic acid concentration between 3-14% DM characterize good quality silage. Also, McDonald *et al.* (2010) mentioned that the lactic acid contents generally lie in the range 8-12% of silage DM. Generally, lactic acid from silage is converted to propionic acid in the rumen under normal feeding conditions (Kung *et al*., 2018).

Table (2): Fermentation characteristics of silages of potato, sweet potato and turnip with rice straw

Silage fermentation characteristics	Potato silage	Sweet potato silage	Turnip silage
pH value	$4.09^{a} \pm 0.06$	$3.80^{b} \pm 0.03$	$4.07^{a} \pm 0.04$
Ammonia-N (g/100g DM)	$0.28^{a} \pm 0.01$	$0.29^{a} \pm 0.02$	$0.26^{b} \pm 0.01$
Ammonia-N (% of total N)	$14.68^{a} \pm 0.01$	$13.46^{b} \pm 0.02$	$14.59^{a} \pm 0.01$
Acetic acid (g/100g DM)	$2.77^{b} \pm 0.01$	$2.66^{b} \pm 0.01$	$3.20^{a} \pm 0.01$
Butyric acid (g/100g DM)	$0.44^{b} \pm 0.01$	$0.73^{a} \pm 0.01$	$0.83^{a} \pm 0.01$
Lactic acid (g/100g DM)	$7.01^{c} \pm 0.01$	$7.43^{b} \pm 0.02$	$8.64^{a} \pm 0.01$

[a,b,c] means in the same row with different superscripts are significantly different (P < 0.05)

Calculated chemical composition of the rations as shown in Table (3) explained that OM and CP of all rations were nearly similar. The CF% was lower and NFE% was higher of Ration A than all rations while the values of CF and NFE% of rations containing silages were nearly similar. The little variation in chemical composition of the rations may be due to the different in chemical composition of ingredients in the rations and feed intake by lambs. Digestion coefficients and nutritive values of experimental rations of growing lambs as shown in Table (3) explained that digestion coefficients of DM and OM of ration A (control) were significantly (P<0.05) higher than rations B and D, while the differences between A and C were not significant. The CP digestibility of ration C was significantly (P<0.05) higher than rations B and D while the differences among rations A, B and D were not significant. The differences among all rations of CF digestibility were not significant. The NFE digestibility of ration A were significantly (P<0.05) higher than all rations. The NFE digestibility of ration B was significantly lower than ration C and was insignificantly lower than ration D and the difference between rations C and D was not significant. However, Sadri *et al.* (2018) found that digestion coefficient of DM, OM, CP and EE by lambs fed ration containing 30% potato-wheat straw silage + CFM + alfalfa were 67.7, 70.3, 67.0 and 74.4%, respectively while, Nkosi and Meeske (2010) found that digestion coefficients of DM, OM, CP and EE by lambs fed ration containing 20% potato-hay silage + 80% CFM were 62.80, 65.20, 53.20 and 58.70%, respectively. The TDN of ration A was significantly (P<0.05) higher than other rations while the differences among other rations were not significant. The DCP of ration C was significantly (P<0.05) higher than rations B and D and insignificantly higher than ration A and the differences among rations A, B and D were not significant.

Table (3): Chemical composition, digestion coefficients and nutritive values of experimental rations by growing lambs

Items	Ration A	Ration B	Ration C	Ration D
Calculated chemical composition (% on DM basis)				
OM	90.87	89.07	88.46	90.45
CP	14.84	14.83	15.46	14.69
EE	3.52	2.68	2.90	3.77
CF	16.13	20.07	19.24	18.19
NFE	56.38	51.48	50.85	53.80
Ash	9.13	10.93	11.54	9.55
Digestion coefficients %				
DM	$68.03^{a} \pm 1.03$	$54.60^{c} \pm 0.68$	$63.28^{ab} \pm 0.80$	$57.75^{bc} \pm 3.58$
OM	$70.39^{a} \pm 0.93$	$59.09^{b} \pm 0.62$	$64.58^{ab} \pm 0.77$	$61.17^{b} \pm 3.29$
CP	$70.41^{ab} \pm 0.52$	$64.20^{b} \pm 0.56$	$71.69^{a} \pm 0.60$	$65.50^{bc} \pm 2.92$
CF	$55.64^{a} \pm 2.62$	$53.07^{a} \pm 0.63$	$52.65^{a} \pm 1.11$	$49.11^{a} \pm 4.32$
EE	$90.74^{ab} \pm 0.22$	$86.11^{c} \pm 0.23$	$88.61^{b} \pm 0.23$	$89.02^{b} \pm 0.93$
NFE	$73.30^{a} \pm 0.74$	$58.56^{c} \pm 0.65$	$65.56^{b} \pm 0.72$	$62.12^{bc} \pm 3.21$
Nutritive values %				
TDN	$67.96^{a} \pm 0.75$	$55.52^{b} \pm 0.57$	$60.34^{b} \pm 0.67$	$59.53^{b} \pm 3.02$
DCP	$10.46^{ab} \pm 0.09$	$9.52^{b} \pm 0.09$	$11.08^{a} \pm 0.09$	$9.62^{b} \pm 0.43$

[a,b,c] means in the same row with different superscripts are significantly different (P<0.05)

Rumen fermentation parameters are presented in Table (4). The maximum ruminal pH values were recorded at 0h time in all groups, and then significantly decreased with advanced time at 2 and 4h post feeding. The pH values of groups fed rations A, B, C and D at 0h time were 6.91, 6.86, 6.73 and 6.82, respectively. The pH at 2h of ration C (6.43) was significantly ($P<0.05$) higher than other rations while the differences at 4h among all rations were not significant. However, ruminal pH values in all rations ranged from 5.58 to 6.91. These values are lie within the normal pH in the rumen as mentioned by Hungate (1966) who mentioned that the normal pH for normally functioning in the rumen is ranged from 5.5 to 7.3. The NH_3-N was significantly ($P<0.05$) increased after feeding than before feeding in all rations. The highest values of NH_3-N were recorded at 2h post feeding of all rations except ration B had the highest value at 4h post feeding. Sugimoto *et al.* (2008) and Osman *et al*. (2007) noticed that the maximum ruminal NH_3-N concentration was showed at 2h post feeding then decreased. The differences of ruminal NH_3-N among all rations at 0h time were not significant while NH_3-N in the rumen of lambs fed ration C was significantly ($P<0.05$) lower than other rations at 2 and 4h post feeding, while the differences among other rations were not significant. Total VFA's concentrations in the rumen of all rations were significantly ($P<0.05$) increased at 2 and 4h after feeding than before feeding. The highest values of TVFA's were recorded at 4h post feeding. The differences of ruminal TVFA's among all rations at all times were not significant except TVFA's in the rumen of group fed rations A was significantly ($P<0.05$) lower than other rations containing silages. The higher values of VFA's in the rumen of lambs fed silages than control may be due to silage is containing VFA's. Sugimoto *et al*. (2008) noticed that total VFA was increased after feeding and ranged from 9 to 11 mMol/dL at 2h post feeding. Microbial protein in the rumen of group fed rations A was significantly ($P<0.05$) lower than other rations while the differences among other rations were not significant. However, the synthesis of rumen microbial protein can be affected by synchronizing of energy releasing by fermentation of carbohydrates and N availability in the rumen as mentioned by Harun and Sali (2019).

Table (4): Rumen fermentation parameters in rumen fluid of growing lambs fed experimental rations

Rumen parameters	Time	Ration A	Ration B	Ration C	Ration D
pH	0	$6.91^{Aa} \pm 0.02$	$6.86^{Aab} \pm 0.08$	$6.73^{Ab} \pm 0.01$	$6.82^{Aab} \pm 0.02$
	2	$5.68^{Cbc} \pm 0.07$	$5.91^{Cb} \pm 0.20$	$6.43^{Ba} \pm 0.10$	$5.58^{Cc} \pm 0.07$
	4	$6.25^{Bab} \pm 0.07$	$6.38^{Ba} \pm 0.04$	$6.25^{Bab} \pm 0.06$	$6.15^{Ba} \pm 0.06$
Ammonia-N (NH3-N) (mg/100ml)	0	$20.53^{Ba} \pm 2.50$	$24.27^{Ba} \pm 2.50$	$21.47^{Aa} \pm 0.93$	$25.20^{Ba} \pm 1.62$
	2	$36.40^{Aa} \pm 4.30$	$39.20^{Aa} \pm 2.80$	$31.73^{Ab} \pm 6.53$	$42.00^{Aa} \pm 0.01$
	4	$35.47^{ABa} \pm 3.73$	$41.07^{Aa} \pm 0.93$	$28.93^{Ab} \pm 0.93$	$37.33^{ABa} \pm 4.70$
Total volatile fatty acids (TVFA's) (mEq/100ml)	0	$5.58^{Ba} \pm 0.30$	$4.58^{Ca} \pm 0.40$	$4.08^{Ca} \pm 0.30$	$5.42^{Ba} \pm 1.50$
	2	$9.92^{Aa} \pm 2.10$	$11.67^{Ba} \pm 1.01$	$11.00^{Ba} \pm 0.80$	$11.33^{Aa} \pm 1.90$
	4	$11.17^{Ab} \pm 1.90$	$15.33^{Aa} \pm 0.74$	$14.17^{Aa} \pm 0.73$	$13.17^{Aa} \pm 0.44$
MP(g/100ml)	4	$0.26^{b} \pm 0.03$	$0.39^{a} \pm 0.04$	$0.37^{a} \pm 0.03$	$0.39^{a} \pm 0.01$

^{A,B,C} means in the same column with different superscripts are significantly different ($P<0.05$)
^{a,b,c} means in the same row with different superscripts are significantly different ($P<0.05$)

Averages of daily intake, daily body gain (DBG), feed conversion and economical efficiency of experimental rations are presented in Table (5). Average total DM intake was 1.285, 0.942, 0.955 and 0.901 kg/lamb/d of rations A, B, C and D, respectively. Nkosi and Meeske (2010) found that daily DM intake of lamb was 1099 g/d of diet containing 20% potato hash silage. Average fresh silage intake of rations B, C and D was nearly similar (812, 842 and 833g/lamb/d, respectively) while silage DM intake was 310, 323 and 269 g/lamb/d. Hart and Horn (1987) found that average DM intake from silage containing turnip-wheat straw was 346 g/lamb/d by lambs weighed 28-34 kg.

The highest value of final body weight was recorded with lambs fed ration D (43.33 kg) followed C, B and A (control). Therefore, total body gain in group D was higher than all groups and consequently the highest daily body gain was obtained of lambs fed ration D (120.75 g/lamb/d) followed rations C (112.24 g/h/d), B (109.69 g/lamb/d) and A (107.99 g/lamb/d). Sadri *et al.* (2018) found that the average DBG was 239 g/d of growing lambs fed mixed potato-wheat straw silage at level 30% from DM of the diet while, Nkosi and Ratsaka (2010) found that average DBG was 101 g/d of lambs fed diet containing 22.5% silage of potato hash-hay with CFM. Nkosi and Meeske (2010) found that average DBG was 192 g/d of lambs fed diets containing 20% potato hash silage. Negesse *et al.* (2016) mentioned that the average DBG was 119.5 g/d of lambs fed sweet potato silage 4% of body weight. However, the growth performance is affected by genetic factors and non-genetic factors such as feeding and animal age.

The best feed conversion was recorded for ration D (7.45) and the bad feed conversion was recorded for ration A (11.90). The feed conversion of rations B and C was nearly similar (8.56 and 8.53). Negesse *et al.* (2016) found that the average feed conversion was 5.22 of lambs fed sweet potato silage as 4% of body weight. Nkosi and Meeske (2010) found that feed conversion was 5.7 of lambs fed diet containing 20% potato hash silage with CFM while, Nkosi and Ratsaka (2010) found that feed conversion was 10.2 of lambs fed diet containing 22.5% potato hash silage with CFM.

The feed cost of rations A (5.806 LE/h/d) was higher than other rations containing silages. The least feed cost was recorded for ration D (4.283 LE/lamb/d) followed ration B and C (4.402, 4.892 LE/lamb/d). The best economical efficiency was recorded with ration D (1.69) followed rations B, C and A. Sugimoto *et al.* (2009) and Aibibula *et al.* (2007) mentioned that potato pulp silage can be low-cost feed source for livestock feeding. Generally, the price of potato, sweet potato and turnip and consequently its silages is directly affect feed cost and economical efficiency of the rations when compared with price of traditional feed ingredients.

Table (5): Average intake, daily body gain (DBG), feed conversion and economical study of experimental rations by growing lambs

Items	Ration A	Ration B	Ration C	Ration D
Average feed intake as fed				
CFM intake(kg/h/d)	1.135	0.685	0.686	0.686
RS intake (kg/h/d)	0.267	-	-	-
Silage intake (kg/h/d)	-	0.812	0.842	0.833
Total, Kg/h/d	1.402	1.496	1.528	1.519
Average feed DM intake				
CFM, g/h/d	1.046	0.632	0.632	0.632
RS, g/h/d	0.239	-	-	-
Silage, g/h/d	-	0.310	0.323	0.269
Total DM intake, g/h/d	1.285	0.942	0.955	0.901
Total DM intake, % of LBW	3.20	2.31	2.29	2.08
Total DM intake, g/kg $w^{0.75}$	80.55	58.29	58.25	53.35
TDN(Kg/h/d)	1.04	0.71	0.73	0.74
DCP (Kg/h/d)	0.14	0.09	0.10	0.09
Body weight				
Initial weight, kg	19.00 ± 1.83	19.33 ± 1.93	19.67 ± 2.03	19.67 ± 1.38
Final weight, kg	40.17 ± 2.83	40.83 ± 2.71	41.67 ± 1.99	43.33 ± 0.92
Total body gain, kg	21.17 ± 1.25	21.50 ± 1.93	22.00 ± 1.53	23.67 ± 0.92
Average DBG, g/h/d	107.99 ± 6.38	109.69 ± 9.84	112.24 ± 7.79	120.75 ± 4.69
Feed conversion (Feed/gain)				
Kg DM /Kg gain	11.90	8.56	8.53	7.45
Kg TDN /kg gain	9.63	6.38	6.50	6.05
Kg DCP/kg gain	1.30	0.82	0.89	0.75
Economical study				
Cost CFM (LE/h/d)	5.675	3.425	3.430	3.430
Cost rice straw (LE/h/d)	0.134	0	0	0
Cost silage (LE/h/d)	0	0.975	1.462	0.854
Total feed cost (LE/h/d)	5.806	4.402	4.892	4.283
Economical efficiency	1.12	1.49	1.38	1.69

Price of live body weight of sheep 60 LE / kg LBW, Price of concentrate feed mixture (CFM) of ton 5000 LE, Price of rice straw (RS) of ton 500 LE. Cost of ton silages potato 1201.76, sweet potato 1737.5 and turnip 1024.8. Economical efficiency = price of weight gain/total feed cost

CONCLUSION

It could be concluded that:

1- Non-commercial and unmarketable of Potato tubers, sweet potato and turnip roots could be ensiling with crop residues such as rice straw and consequently using in lambs feeding.

2- More studies are needs for using roots and tubers silages in ruminant feeding.

3- The turnip is promising forage crop for animal feeding as silage in Egypt.

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التركيب الكيميائى وخصائص التخمر لسيلاجات البطاطس والبطاطا واللفت مع قش الأرز ودراسة تأثير العلائق المحتوية على السيلاج على الآداء والكفاءة الاقتصادية للحملان النامية

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أجريت هذه الدراسة بهدف تقييم سيلاجات درنات البطاطس وجذور البطاطا وجذور اللفت الغير تجارية. وقد تم فيها عمل السيلاج أوتوماتيكيا في أكياس وقد تم استخدام السيلاج في تغذية الحملان النامية. وقد تم استخدام أربعة وعشرين من الحملان النامية المحلية بمتوسط وزن الجسم 19,4 كجم قسمت إلى أربعة مجموعات (6 في كل مجموعه) وذلك لتقييم أربعة علائق تجريبية على النحو التالي: العليقة أ: 100٪ من متطلبات البروتين الخام وفقا لمقررات NRC لسنة 1985 من خليط العلف المركز + قش الأرز للشبع. العليقة ب: 60٪ من متطلبات البروتين الخام وفقًا لمقررات NRC لسنة 1985 من العلف المركز + سيلاج البطاطس. العليقة ج: 60٪ من متطلبات البروتين الخام وفقا لمقررات NRC لسنة 1985 من العلف المركز + سيلاج البطاطا الحلوة. العليقة د: 60٪ من متطلبات البروتين الخام وفقا لمقررات NRC لسنة 1985 من العلف المركز + سيلاج اللفت. وقد كان العلف المركز يقدم للحملان على فترتين صباحا ومساءا وكان السيلاج يقدم للشبع واستمرت تجربة النمو 28 أسبوعًا وكان يتم وزن الحيوانات كل أسبوعين في الصباح قبل تقديم الغذاء. وقد أجريت أربع تجارب هضم لتقييم العلائق التجريبية (أ، ب، ج، د) باستخدام 12 حمل من المجموعات التجريبية (3 حملان من كل مجموعة لتقييم كل عليقة) بمتوسط وزن 36,5 كجم. وقد تم إجراء تحليل كيماوي للمعاملات وإجراء مقاييس تخمر السيلاج. كما تم تقييم أداء النمو وكفاءة التحويل الغذائي والكفاءة الاقتصادية. وقد أوضحت النتائج أن نسبة المادة الجافة لسيلاج البطاطس وسيلاج البطاطا وسيلاج اللفت كان 38,15 و 38,34 و32,25٪ على التوالي. وكان محتوى المادة العضوية في سيلاج البطاطس والبطاطا واللفت 85,46 و 83,97 و 88,47٪ على التوالي. وكان محتوى البروتين الخام في سيلاج البطاطس والبطاطا واللفت 12,06 و 13,56 و 11,16٪ على التوالي. وقد أظهرت قياسات جودة تخمر السيلاج في السيلاجات التجريبية والمحتوية على البطاطس والبطاطا واللفت مع قش الأرز أن قيم أرقام الحموضة (pH) كانت 4,09 و3,8 و4,07 على التوالي. وكانت قيم الأمونيا- نيتروجين (جم/100 جم مادة جافة) 0,28 و 0,29 و 0,26 على التوالي وكانت نسب الأمونيا- نيتروجين (٪ من إجمالي النيتروجين الكلى) 14,68 و 13,46 و 14,59٪ على التوالي. كانت قيم حامض الخليك (جم/100 جم مادة جافة) 2,77 و 2,66 و 3,20 على التوالي وكانت قيم حامض البيوتيريك (جم/100جم مادة جافة) 0,44 و0,73 و 0,83 على التوالي وكانت قيم حامض اللاكتيك (جم/100جم مادة جافة) 7,01 و 7,43 و 8,64 على التوالي. وقد كانت معاملات الهضم للعلائق التجريبية أ, ب, ج, د المغذاة بواسطة الحملان النامية بالنسبة للمادة الجافة المهضومة 68,03 و 54,60 و 63,28 و 57,75٪ على التوالي. وكان معامل هضم المادة العضوية 70,39 و 59,09 و 64,58 و 61,10٪ على التوالي وكان معامل هضم البروتين الخام 70,41 و 64,20 و 71,69 و 65,50٪ على التوالي. وكان معامل هضم الألياف الخام 55,64 و 53,07 و 52,65 و 49,11٪ على التوالي. وكان معامل هضم مستخلص الإثير 90,74 و 86,11 و 88,61 و 89,02٪ على التوالي. وكان معامل هضم المستخلص الخالي من النيتروجين 73,30 و 58,56 و 65,56 و 62,12٪ على التوالي. وقد كانت قيم المركبات الكلية المهضومة 67,96 و 55,52 و 60,34 و 59,50٪ على التوالي وكانت قيم البروتين الخام المهضوم 10,46 و 9,52 و 11,08 و 9,62٪ على التوالي. وأظهرت قياسات التخمرات في الكرش انخفاض أرقام الحموضة pH بعد التغذية معنويا عما كان عليه قبل التغذية ولم تكن الفروق بين جميع العلائق معنوية عند 4 ساعات بعد التغذية. وقد تراوحت قيم أرقام الحموضة في جميع العلائق من 5,58 إلى 6,91. وقد زادت الأمونيا نيتروجين والأحماض الدهنية الطيارة معنويا بعد التغذية عما كان عليه قبل التغذية. وكانت الأمونيا نيتروجين في الكرش للعليقه ج أقل معنويا من العلائق الأخرى في حين أن الاختلافات بين العلائق الأخرى لم تكن معنوية ولم تكن الاختلافات في الأحماض الدهنية الطيارة معنوية بين جميع العلائق باستثناء العليقة أكانت أقل معنويا عن العلائق الأخرى. كان البروتين الميكروبي للعلائق أ, ب, ج, د 0,26 و 0,39 و 0,37 و 0,39 جم/100 مل سائل كرش على التوالي. كانت قيم متوسط المادة الجافة المأكولة خلال فترة النمو 1,285 و 0,942 و 0,955 و 0.901 كجم/ رأس/يوم للعلائق أ, ب, ج, د على التوالي وكانت قيم متوسط المادة الجافة المأكولة من السيلاج 0,310 و 0,323 و 0,269 كجم/ رأس/ يوم من العلائق ب, ج, د على التوالي. وكانت قيم متوسط النمو اليومي للحملان المغذاة على العلائق أ, ب, ج, د 107,99 و 109,69 و 112,24 و 120,75 جم/ رأس/يوم على التوالي. وكانت قيم معدل التحويل الغذائي للعلائق أ, ب, ج, د 11,90 و 8,56 و 8,53 و 7,45 كجم مادة جافة/كجم نمو على التوالي. وقد كانت تكلفة الغذاء للعلائق أ , ب , ج , د 5,806 و 4,402 و 4,892 و 4,283 جنيها لكل رأس/يوم على التوالي وكانت قيم الكفاءة الإقتصادية 1,12 و 1,49 و 1,38 و 1,69 على التوالي.